

WHAT IS CLAIMED IS:

1. A dual fuel engine, said engine supplied with diesel fuel and at least one secondary fuel, said engine including one or more cylinders in which one or more pistons reciprocate, each of said one or more cylinders being provided with diesel injection
5 means for injecting the diesel fuel into the cylinder during an appropriate stroke of the piston and at least one air inlet valve, said valve moving to an open condition during said appropriate stroke of the piston to permit air flow therethrough, characterised in that each cylinder of the engine is further provided with secondary fuel injection means for injecting the secondary fuel into the cylinders, the secondary fuel injection means being
10 independent of the diesel fuel injection means and air inlet valves.

2. An engine according to claim 1 characterised in that control of the operation of the secondary fuel injection means is independent of the operation of the diesel injection means.

3. An engine according to claim 1 characterised in that the secondary fuel injection
15 means are controlled to introduce the secondary fuel in the one or more cylinders on the appropriate stroke of the piston reciprocating therein.

4. An engine according to claim 1 characterised in that the engine is provided with two fuel supply tanks for the diesel fuel and secondary fuel respectively, each fuel being delivered to the engine through separate supply means.

5. An engine according to claim 1 characterised in that injection of the secondary
20 fuel into the one or more cylinders occurs substantially simultaneously to injection of the diesel fuel into said cylinders.

6. An engine according to claim 1 characterised in that means are provided for sensing and/or controlling one or more engine operating conditions.

7. An engine according to claim 6 characterised in that sensing means are provided
25 for sensing any or any combination of exhaust emissions, exhaust gas particulate density, throttle position, temperature of the secondary fuel being delivered to the engine and/or the engine itself, turbo pressure, airflow velocity and pressure, secondary fuel gauge,

engine speed, position of a flow control means and/or position of the diaphragm in the vaporising means.

8. An engine according to claim 6 characterised in that flow control means are provided for regulating the amount of secondary fuel flowing into the engine.

5 9. An engine according to claim 8 characterised in that control of the flow of the secondary fuel to the secondary fuel injection means by said flow control means is regulated dynamically according to one or more sensed engine operating characteristics.

10. An engine according to claim 8 characterised in that the flow control means are provided in fuel supply pipes supplying secondary fuel to the engine.

10 11. An engine according to claim 8 characterised in that an output of the flow control means is coupled to an input of a multi-output divider for dividing a singular flow of secondary fuel into a plurality of flows, the number of flows corresponding to the number of cylinders in the engine and each of said flows being coupled to the secondary fuel injection means.

15 12. An engine according to claim 8 characterised in that the flow control means includes a piston, the position of which is changed to alter the amount of secondary fuel flowing therethrough.

13. An engine according to claim 1 characterised in that vaporising means is provided in fuel supply means for delivering the secondary fuel to the engine.

20 14. An engine according to claim 6 characterised in that an integrated control unit (ICU) is provided for controlling one or more engine operating conditions.

15. An engine according to claim 14 characterised in that the ICU includes any or any combination of:

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- a) one or more inputs in communication with sensing means disposed in and/or around the engine for sensing one or more operating characteristics thereof
 - b) means capable of receiving and/or processing a user input
 - c) calibration means through which maintenance and adjustment of one or

more algorithms and/or operating parameters of the ICU can be achieved

d) one or more outputs for displaying data relating to the operating characteristics of the engine

e) one or more outputs for connection to one or more dynamically adjustable components of the engine for dynamic control thereof during engine operation.

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16. An engine according to claims 13 and 14 characterised in that the ICU controls the flow of secondary fuel through a diaphragm in the vaporising means and/or the temperature of a heating element provided therein.

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17. An engine according to claims 8 and 16 characterised in that the ICU controls both the flow control means and the diaphragm in the vaporising means for regulating the flow of the secondary fuel through each component.

18. An engine according to claim 14 characterised in that operation of the ICU is substantially continuous.

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19. An engine according to claim 14 characterised in that the ICU includes memory means for storing one or more pre-determined engine operating conditions therein.

20. An engine according to claim 19 characterised in that the memory means includes one or more algorithms which can be executed by processing means when pre-determined conditions are met.

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21. An engine according to claim 20 characterised in that said pre-determined conditions include any or any combination of when the engine is started, when the secondary fuel runs out and/or when the load on the engine reaches a pre-determined level or is outside a pre-determined level.

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22. An engine according to a preceding claim characterised in that the calculations resulting from executing said algorithms are used to set the vaporiser diaphragm or piston of the flow control means to an optimum level for the detected operating conditions.

23. An engine according to claim 20 characterised in that at least one recalibration algorithm is provided for allowing the ICU to adjust its operation as the engine and its associated component undergo wear.

5 24. An engine according to claim 19 characterised in that data input from sensing means to the ICU is compared to pre-determined engine operating conditions and the ICU outputs data to adjust the flow of the secondary fuel to the engine and/or one or more other engine operating parameters.

25. An engine according to claim 1 characterised in that a secondary fuel limiter is provided to prevent "over-powering" of the engine.

10 26. An engine according to claim 1 characterised in that emergency shut off valves are provided in fuel supply means which deliver the diesel fuel and the secondary fuel to the engine.

15 27. An engine according to claim 1 characterised in that traction control means are provided and, on detection of a loss of traction, the supply of secondary fuel to the engine is reduced or cut off.

28. An engine according to claim 1 characterised in that the secondary fuel is LPG.

20 29. A vehicle having a dual fuel engine fitted therein, said engine supplied with diesel fuel and at least one secondary fuel, said engine including one or more cylinders in which one or more pistons reciprocate, each of said one or more cylinders being provided with diesel injection means for injecting the diesel fuel into the cylinder during an appropriate stroke of the piston and at least one air inlet valve, said valve moving to an open condition during said appropriate stroke of the piston to permit air flow therethrough, characterised in that each cylinder of the engine is further provided with secondary fuel injection means for injecting the secondary fuel into the cylinders, the secondary fuel
25 injection means being independent of the diesel fuel injection means and air inlet valves.

30. An integrated control unit (ICU) for controlling the operation of a dual fuel engine, said engine supplied with diesel fuel and at least one secondary fuel, said engines including one or more cylinders in which one or more pistons reciprocate, each of said

one or more cylinders being provided with diesel injection means for injecting the diesel fuel into the cylinder during an appropriate stroke of the piston and at least one air inlet valve, said valve moving to an open condition during said appropriate stroke of the piston to permit air flow therethrough, each cylinder of the engine being further provided with
5 secondary fuel injection means for injecting the secondary fuel into the cylinders, the integrated control unit providing independent control for the operation of the secondary fuel injection means and the diesel fuel injection means.

31. An ICU according to claim 27 characterised in that control of the operation of at least said secondary fuel injection means is in response to one or more sensed engine
10 operating characteristics.

32. A method of converting a diesel engine to a dual fuel engine, said engine supplied with diesel fuel and at least one secondary fuel, said engine provided with one or more cylinders in which one or more pistons reciprocate with injection means for injecting diesel fuel into the cylinder during an appropriate stroke of the piston and at least one air
15 inlet valve, said valve moving to an open condition during said appropriate stroke of the piston to permit air flow therethrough, characterised in that said method includes the step of providing each cylinder of the engine with secondary fuel injection means for injecting the secondary fuel into the cylinders, the secondary fuel injection means being provided independently to the diesel fuel injection means.